MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

EME 2066 – MEASUREMENT AND INSTRUMENTATION

(ME)

30 MAY 2017
2.30 p.m. – 4.30 p.m.
(2 Hours-OPEN BOOK EXAMINATION)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages including cover page with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks.The distribution of the marks for parts of each question is shown.

3. Please write all your answers in the Answer Booklet provided.

4. This is an **OPEN BOOK** examination. The book allowed is, " Experimental Methods for Engineers" by J.P.HOLMAN, McGraw Hill Publication, 8th Edition (***only printed book is allowed***).

5. Please refer to the above book for any additional data require

QUESTION 1

(a) A temperature sensor initially at a temperature of 30°C , is suddenly exposed to a temperature of 100°C. It indicates a temperature of 50°C after 0.8 s. Determine the time constant of the sensor, considering that, it operates as a first order system. Sketch the variation of temperature with time. [6 marks]

(b) The power (P) in a circuit is given by $P=EI$.
$E = 220V \pm 5\%$; $I = 5A \pm 2\%$
Calculate the nominal value of power and its uncertainty. [6 marks]

(c) A pressure transducer with unknown resistance is placed in one arm of a Wheatstone bridge, the other arms of which have resistances of 400 Ω. A 6V battery with negligible internal resistance is used in the circuit. The galvanometer resistance is 100Ω, If the galvanometer current is 30 micro-amperes, calculate the unknown resistance of the transducer. [10 marks]

(d) A two-stage amplifier has a first stage gain of 250 and a second stage gain of 30. If the input voltage to the first stage is 4 mV, determine the output of second stage in dB referred to 1mV. [3 marks]

QUESTION 2

(a) A U-tube manometer uses mercury as the manometer fluid to measure a differential pressure in water at 293 K. Both sides of the manometer have diameters of 2.5 mm.

(i) If the difference in the heights of the two columns is 111 mm, find the differential pressure in Psig unit? [5 marks]

(ii) If the same pressure differential of Glycerin is measured in the same U-tube with the same column height difference at 293 K, what is the density of the manometer fluid? [2 marks]

(b) A McLeod gage has a volume V_b of 150 cm^3 and a capillary tube diameter of 0.3mm. Calculate the gage reading for a pressure of 40 μm. [5 marks]

Continued.....

(c) A rotameter is to be designed to measure a maximum flow of 10 GPM of water at 70°F. The bob has 1-inch diameter, weighs 80g and a total volume of 50 cm^3. The bob is constructed so that the density is given as $\rho_b = 2\rho_f$. The total length of the rotameter tube is 13 inches and the diameter of the tube inlet is 1.5 inch. Given that the annular area and drag coefficient are 10 cm^2 and 0.4 respectively, assuming that $g = g_c$, Determine :

(i) tube taper [3 marks]
(ii) mean flow velocity [2 marks]
(iii) volumetric flow rate [2 marks]

(d) Air at 600KPa at 20°C flows in a circular tube having diameter of 8cm at a rate such that Reynolds number Re is $1x10^6$.Calculate the flow rate in units of kg/s and m^3/s. [6 marks]

QUESTION 3

(a) A platinum RTD has linear temperature coefficient of 0.00392 /° C. The resistance is measured using a bridge circuit with R_1=250 Ω, R_2=120 Ω, R_3= 60 Ω at 20 ° C as shown in Fig.Q3(a)

(i) Find the resistance at 40 ° C. [4 marks]
(ii) Find the sensitivity of the RTD. [3 marks]

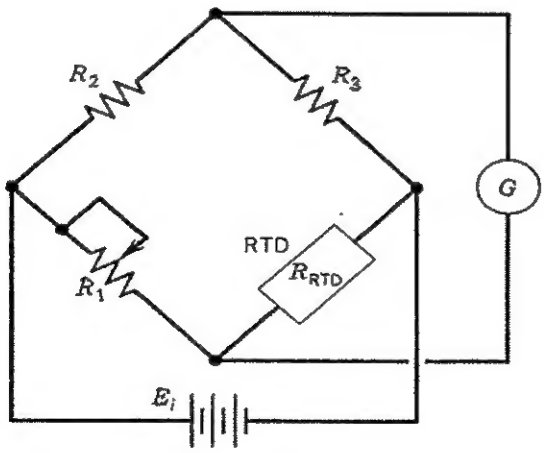

Fig.Q3(a)

Continued.....

(b) An apparatus shown in Fig. Q3(b) is to be used to measure the thermal conductivity of an unknown rod having an approximate value of $k = 18$ W/m·°C. The known rod used for comparison has $k = 55$ W/m·°C.

(i) Calculate the heat flux for an overall temperature difference of 35°C if sample and standard have nominal lengths of 8cm and 12cm. [5 marks]

(ii) If a Rod C of 9 cm length is connected in the same configuration, resulting in a heat flux of 4086 W/m^2, what is the thermal conductivity k of Rod C?

[3 marks]

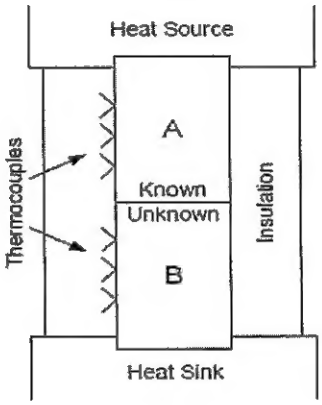

Fig. Q3(b)

(c) A slug type heat-flux sensor has $U = 0.1$ W/m^2.°C. The slug is a copper cube 5 mm on a side embedded in a wall. What heat flux would be necessary to produce a rise in temperature of the sensor of 100°C in a time of 30s? given? Given $\rho_{copper} = 8890$ kg/m^3 and $c_{copper} = 398$ J/kg.°C. [4 marks]

(d) A thermocouple bead has the approximate shape of a sphere 1.5 mm in diameter. Assume the properties may be taken as those of Copper. Suppose such a bead is exposed to a convection environment where h =60 W/m^2 °C. Estimate the time constant for the thermocouple. [6 marks]

Continued.....

QUESTION 4

(a) A 2 cm diameter rod, 60 cm long, is subjected to an axial load and the strain measured with the gage factor is 1.7. The voltage source is 4.5 V.

(i) What axial force in Newton would be necessary to produce an axial deformation of 11μm, assuming that the young's modulus of steel is 28.3×10^6 psi? [8 marks]

(ii) What would be the resulting gage reading in volts for the axial deformation in part (i), if the strain gage is placed in an equal-arm bridge in which all resistance are equal to 160Ω? [7 marks]

(b) A set of strain gages is placed on a steel plate with young modulus of 28.3×10^6 psi and Poisson's ratio of 0.3 in the arrangement shown in Fig.Q4(b). The strains of each gage are indicated as:

$\varepsilon 1 = 400\ \mu in/in;\ \varepsilon 2 = 84\ \mu in/in;\ \varepsilon 3 = -250\ \mu in/in$

Calculate the principal strains and stresses, the maximum shear stress and the orientation angle for the principal axes. [10 marks]

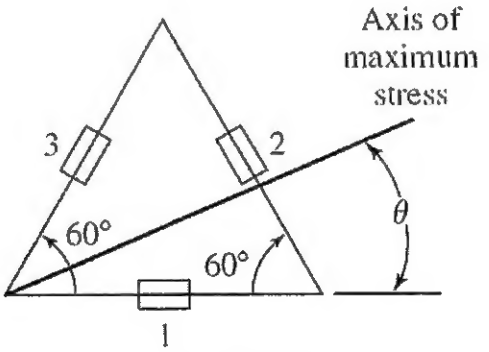

Fig.Q4(b)

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